Appendix 17.3A – Kellystown Geophysical Survey Report

GEOPHYSICAL SURVEY REPORT

Project

ARCHAEOLOGICAL MAGNETIC GRADIOMETRY SURVEY

Location

Kellystown, County Dublin

Client

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Archaeological Magnetic Gradiometry Survey

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Client

Courtney Deery Heritage Consultancy

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Date:	February 2024	

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1 EXECUTIVE SUMMARY

This report describes a geophysical survey conducted within the townlands of Kellystown and Poterstown, Co. Dublin. An initial phase of survey work was conducted on the 29th of November, 2023 and completed on the 16th of February, 2024.

The current proposed development site (PDS) is being considered for a residential-led development, and a geophysical survey is required. A high-resolution magnetic gradiometry survey covering all accessible parts of the survey area was conducted to identify features that may be of archaeological significance.

The total surveyed area across all the sites is ~7.4 ha and comprises several green fields. The site comprises a large field to the west in Kellystown townland and three parcels to the east in Porterstown townland. The boundary between the two townlands is sinuous. The PDS is centred on Irish Transverse Mercator (ITM) grid coordinates (705850,737550).

The geophysical survey is being conducted under Licence No. 23R0523, issued by the National Monuments Service (NMS).

Anomalous geophysical features of interest have been digitised and presented as summary archaeological interpretation plots.

Three sites that are likely to represent archaeological features have been identified.

2 INTRODUCTION

This report describes a geophysical survey conducted within the townlands of Kellystown and Poterstown, Co. Dublin. An initial phase of survey work was conducted on the 29th of November, 2023 and completed on the 16th of February, 2024.

The proposed development site (PDS) is being considered for residential-led development. A high-resolution magnetic gradiometry survey covering all accessible parts of the survey area was conducted to identify features that may be of archaeological significance.

The geophysical survey was conducted under Licence No. 23R0523, issued by the National Monuments Service.

2.1 Site description

The PDS is mainly a greenfield environment within the townland of Kellystown; the eastern extent of the survey area enters Porterstown and includes an area thought to have been previously used as a site construction compound. The site is centred on Irish Transverse Mercator (ITM) grid coordinates (705850,737550). The site measures ~8 ha and has a total surveyable area of ~7.4 ha. Plate 1 shows the site location, and Plate 2 shows the extent of the PDS in detail.

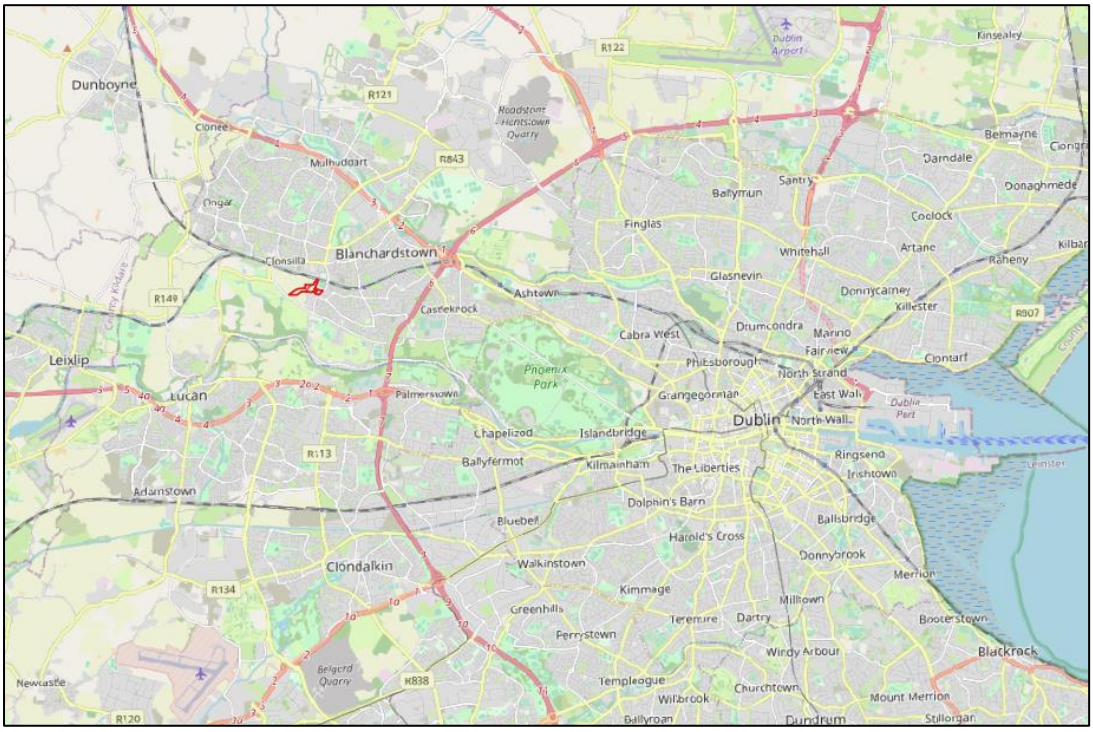

Plate 1: *Site location*

Plate 2: *Detail of the survey area. Survey area (blue outline) and accessible areas surveyed (red hatched areas).*

2.2 Geological setting

The Geological Survey Ireland (GSI) shows that the survey area is mostly underlain by Till derived from limestones (Plate 3, left). The bedrock geology consists of calcareous shale, limestone conglomerate of the Tober Colleen Formation and some dark limestone and shale of the Lucan Formation in the eastern extents of the survey area (Plate 3, right). The geology is thought likely to have a significant effect on the results of the geophysical survey.

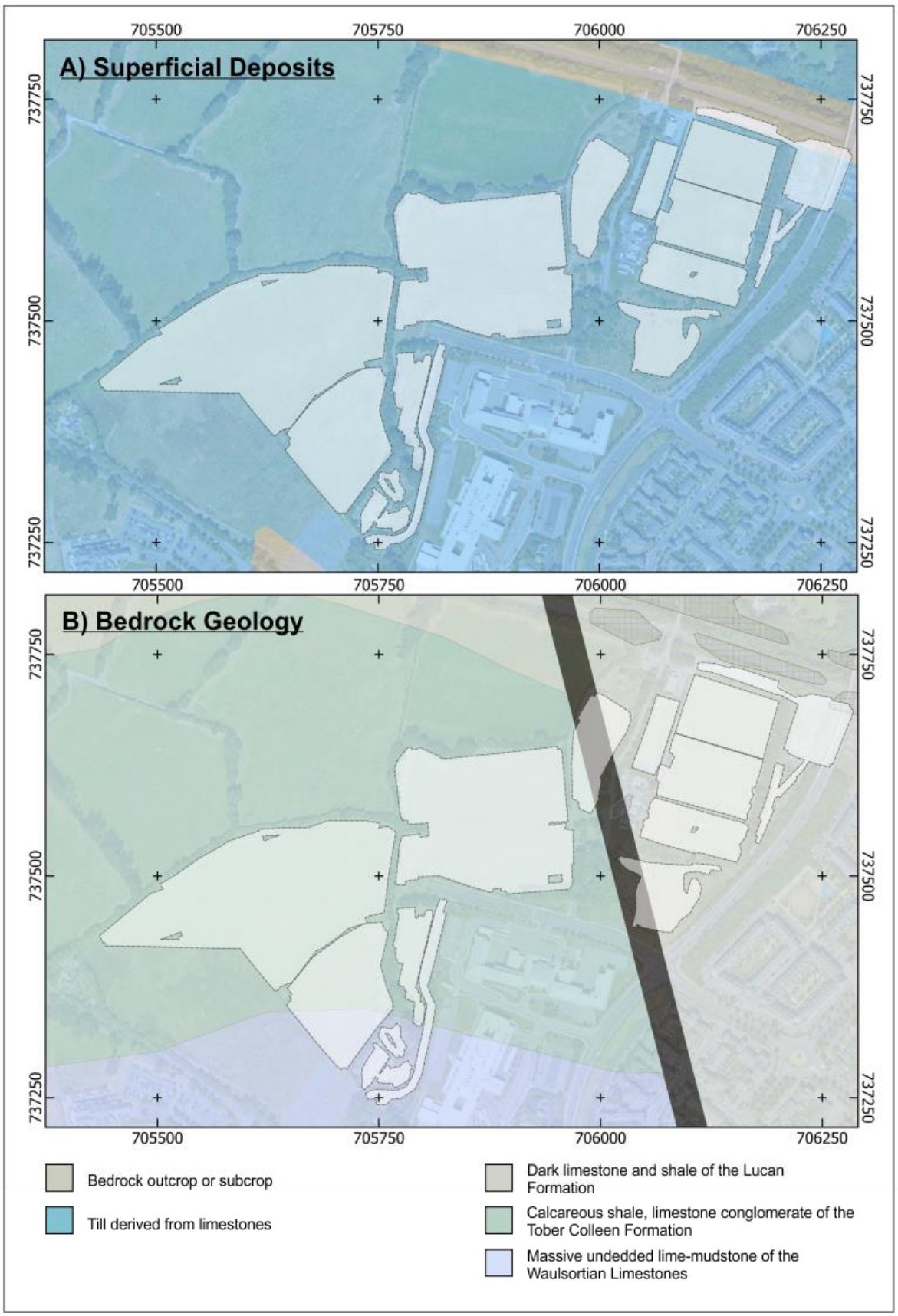

Plate 3: *Superficial geology (A) and solid geology (B) of the site and surrounding area*

2.3 Administrative and archaeological setting

The PDS is mainly a greenfield environment within the townland of Kellystown; the eastern extent of the survey area enters Porterstown and includes an area thought to have been previously used as a site construction compound. The eastern part of the survey area comprises several sports pitches and areas of hardstanding associated with St Mochtas Football Club. No Sites and Monuments Records (SMR) are within or near the site boundary.

2.4 Survey objectives

The primary objective of the geophysical survey is to locate and describe any detectable archaeological features present. The survey will provide context and insight as a standalone document and facilitate any subsequent fieldwork phase by indicating the detected features' location, character, extent, and potential significance.

The geophysical survey results will inform any subsequent archaeological assessment and the design layout. Therefore, it is being conducted before the other archaeological evaluations.

2.5 Quality control

The geophysical data were collected per standard operating procedures outlined by the instrument manufacturer and TerraDat company policy. All services and reports are undertaken to the highest standards to BS 5930:2015 (site investigation) and meet the standard required by The Chartered Institute for Archaeologists' Standard and Guidance for Archaeological Geophysical Survey (2014).

On completion of the survey, the data were downloaded from the survey instrument onto a computer and backed up appropriately. The acquired data set was initially checked for errors that may be caused by instrument noise, low batteries, positional discrepancies, etc., and any field notes were either written up or incorporated in the initial data processing stage. The data set was then processed using standard processing routines. Once processed, the resulting plots are subject to peer review to ensure the integrity of the interpretation. Our quality control standards are BS EN ISO 9001:2015 certified.

3 SURVEY DESCRIPTION

The survey was conducted using magnetic gradiometry. The results are presented in the form of interpreted data plans indicating the location and physical characteristics of identified anomalous features together with a text description.

3.1 Topographic survey/grid layout

The *SENSYS MAGNETO MXV3* data acquisition is controlled by proprietary software *MONMX,* which provides a real-time graphical display of ground coverage based on the RTK GPS positioning system mounted on the trailer. Survey traverses are acquired to provide as little overlap between traverses as possible while minimising any gaps between the traverses. Survey traverses are driven as straight as is reasonably practicable until the entire field is covered, after which 'headland' files are acquired at the field edges to ensure maximum coverage.

3.2 Magnetic survey

Magnetic surveys exploit the subtle deviation in the Earth's magnetic field caused by objects/materials of variable magnetic properties in the subsurface. These properties include ferromagnetism, remanent magnetism, and magnetic susceptibility. In an archaeological setting, these tend to be buried ferrous objects, burnt materials, or the disturbance or accumulation of naturally occurring ferrous minerals within the soil. The recorded data value is the magnetic gradient (the difference in the magnetic field strength recorded by two vertically separated fluxgate magnetometers).

A plan image showing the variation in the magnetic gradient of the site survey area is produced. Based on the recorded magnetic variation, it is possible to identify buried archaeological features such as walls, hearths, kilns, ditches, and pits.

3.2.1 Magnetic survey - field activity

The magnetic gradiometry data were acquired using a multi-sensor array (8 fluxgate gradiometer probes installed at 0.5m sensor separation) mounted on a specialist modular (*Sensys Magneto MXV3*; Plate 4). Network-corrected RTK GPS provides real-time GPS positioning. Across the agricultural fields, the trailer was towed behind an ATV (Plate 4) at speeds of <15 km/h, whereas it was manually pulled over the sports fields to avoid damage. This system allows for the acquisition of 0.5m horizontal resolution gradiometry data within a 3.5m wide swathe. The data were acquired at a rate of 200Hz, nominally providing data at 0.025m intervals along each traverse. This approach enhances resolution (double that of a

conventional hand-held instrument in both x and y directions) and acquisition rate; However, a trade-off can be a poorer signal-to-noise ratio.

Plate 4: *John Deer Gator and Sensys Magneto MXV3 (Library photo).*

3.2.2 Magnetic survey - data processing

The gradiometry data were acquired using *SENSYS* proprietary software *MONMX*, which produces a data file for each acquired survey line. These files are compiled in *DLMGPS*, which associates each gradiometry data point with a GPS coordinate, calculated based on the location of each sensor within the array, thus creating a single swathe of gradiometry data up to 3.5m wide. The software applies a constant median filter to normalise the data within each swathe; the data are then exported as raw ASCII files.

The ASCII files output from *DLMGPS* were further processed using TerraDat proprietary software *MagMerge* (Plate 5) to remove any poor-quality data (sensor drop-outs/data spikes,

etc/overlapping data.) and apply 50Hz and rolling median filters. The 50Hz filter removes artefacts principally associated with electrical power lines, while the median filter equalises the background data across the swathes within a dataset, removing any apparent striping between them. Plate 6 shows an example of raw data alongside filtered data. Table 1 details the processing steps that are applied to the ASCII data;

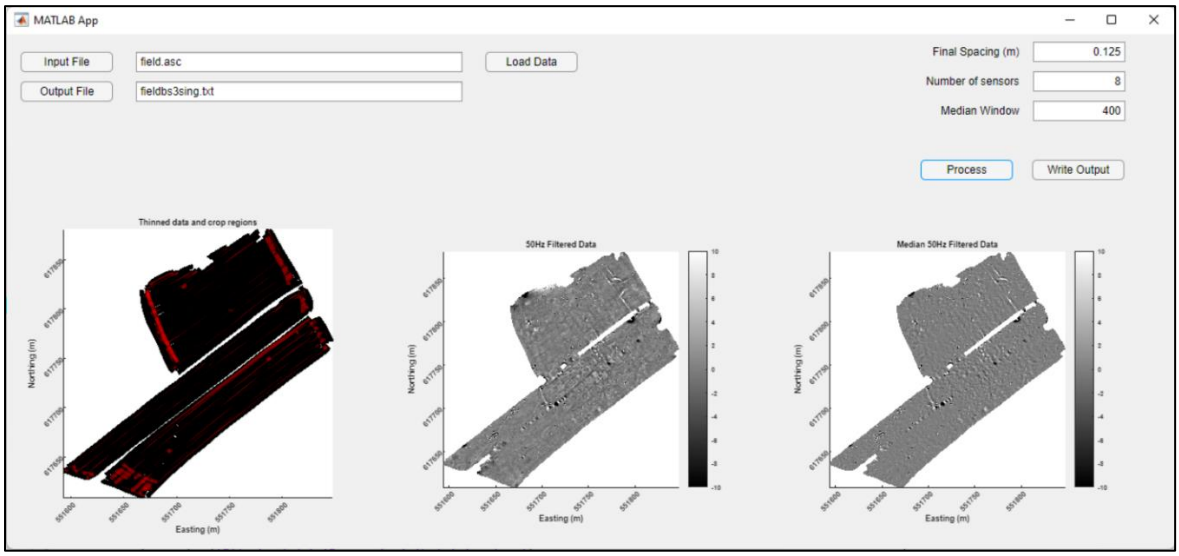

Plate 5: *TerraDat proprietary software MagMerge*

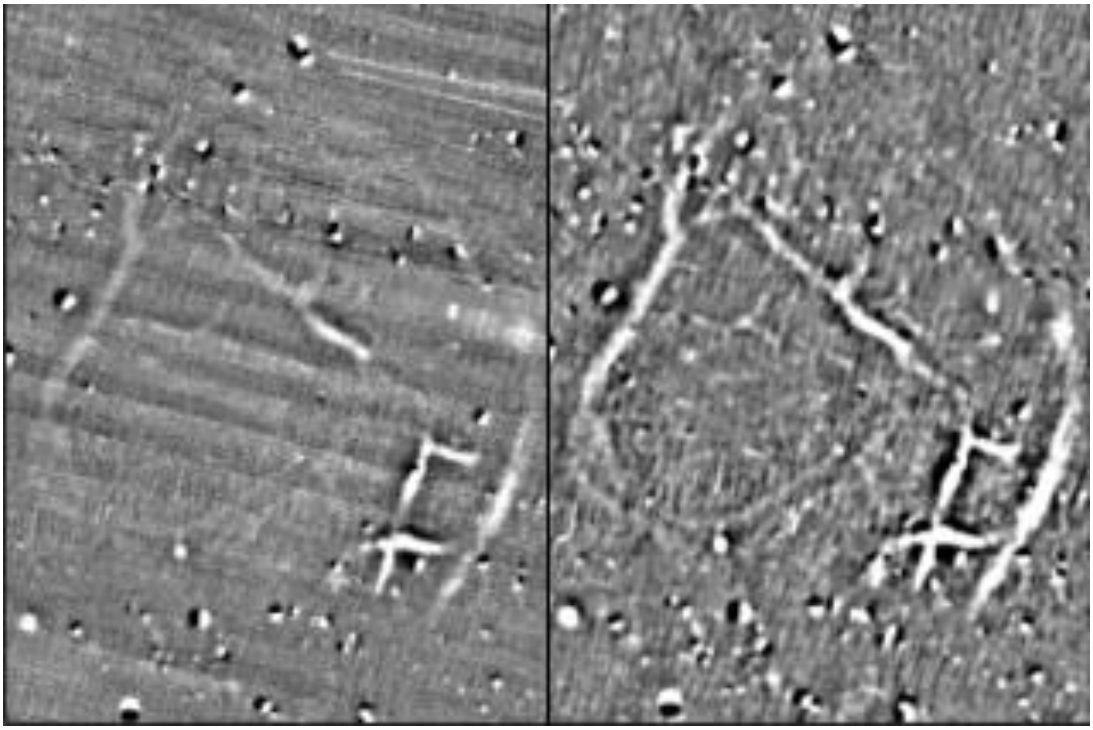

Plate 6: *Raw data (left) and filtered data (right)*

Processing Step	Description
Raw data input	Raw data (.asc) file is imported, and X,Y,Z,gradient,Time_stamp,sensor columns are retained. All other columns are removed.
Truncate Time_Stamp	Alphanumeric Time_stamp variable is truncated to the last digits (e.g. L1_20221007-095821_GZ.prm becomes 95821) to create unique IDs for each line.
Create line_number	Variable 'line_number' (i.e. 1 to #lines) is created by identifying all unique 'Time_stamp' values.
Rolling median	The median filter is calculated per line, per sensor, on values within -/+20nT and removed from the gradient to create a new 'GM' column. The rolling median filter has a window length of 400 data points centred on the input value. Therefore, the first and last 200 data points do not have sufficient information to calculate the median. In these cases, the first calculated value is applied back to the start of the line, and the last calculated value is filled forward to the end of the line. In practical terms, the median window length is equivalent to 10m of data acquisition.
Filter 50Hz Noise	50Hz noise from electrical utilities is removed through wavelet analysis, signal decomposition, and a 50Hz Bandstop filter. Both methods yield similar results. Multiple combinations of median and 50Hz filters are created (i.e. G50, G50M, G50BS and G50BSM) for comparison.
Calculate Mean Spacing	Mean along-track spacing is calculated.
Thin data	Data are thinned to specified output resolution using the calculated mean spacing
Crop overlapping data	Calculate bounding polygons around each line of data. Remove data located within reverse-ordered overlapping polygons.
Display Data	Plot thinned data and cropped areas, plot 50Hz filtered data, plot median filtered data.
Write output file	Write output file containing thinned data with X,Y,Z, gradient,Time_stamp,sensor,Gm,G50,G50M,linenum,G50BS,G50BSM.
Write output GPS	Write output X,Y,Z gps file using centre (actual GPS) data.

***Table 1**: Processing steps applied to the raw magnetic gradiometry data.*

The magnetic gradiometry data is output as raw and filtered 'XYZ' files in .CSV format. The height data from the GPS is also output as an approximately 3m x 0.125m resolution DTM of the Site. These files are gridded in Oasis Montaj, using minimum curvature gridding and a grid cell size of 0.125m. Once the data is gridded and an appropriate colour scale applied, the data is exported as high-resolution GeoTiff images (900 DPI) before being imported into the open-source GIS software qGIS. Features of interest are then digitised to produce summary archaeological interpretation plans. These are integrated with the DTM to allow consideration of any identified archaeological features within the site's topography. Final figures are created in CorelDraw.

4 RESULTS AND DISCUSSION

The final processed data quality is good. There is an issue with the persistence of subtle 'tank-tracking' (narrow longitudinal oscillations in background values between +/-1 nT) due to the slight bobbing motion of the cart and a few holes/gaps in the data where adjacent traverses have not overlapped correctly or due to obstructions/poor site conditions, specifically the presence of significantly wet or soft ground. These inaccessible areas represent a relatively small percentage of the overall survey area.

The data are presented as a series of grey-scaled plots exhibiting variations in the intensity of the magnetic gradient across the survey area. Both raw and processed magnetic data are used for the archaeological interpretation; therefore, both data types are presented in the figures. The figures are presented at 1:2500. A list of figures is provided in Section 4.1.

Anomalous geophysical features of interest have been digitised and presented as summary interpretation plots; Plate 7 presents a key to be used in conjunction with these plots.

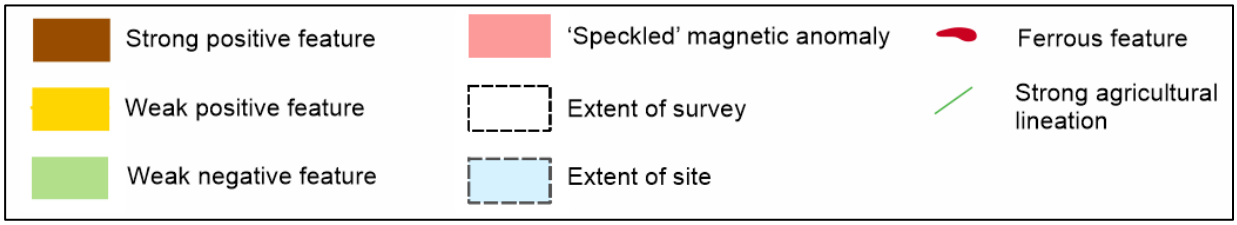

***Plate 7**: Key to be used in conjunction with the interpretive plots*

4.1 List of figures

4.2 Magnetic gradiometry

Magnetic gradiometry (measurement of the vertical gradient of the Earth's magnetic field, using two sensors, one positioned above the other typically at 1.0m separation) developed from magnetometry (measurement of the Earth's magnetic field strength, using a single sensor) to free magnetic surveys from the constraint of requiring base-station measurements to compensate for diurnal variation in field strength.

The identified magnetic anomalies (i.e. areas with a magnetic gradient that deviates from that of the typical site background) may be due to the influence of one of three main magnetic properties: ***ferromagnetism*** (that exhibited by a magnetic object of ferrous metal), ***remanent magnetism*** (a permanent sympathetic magnetic field acquired during the cooling of a hot object, commonly seen in both fixed archaeological features such as hearths, as well as portable materials, such as ceramic building material [CBM]) and most importantly of all, ***magnetic susceptibility*** ([MS], a measure of the temporary sympathetic magnetic field generated by a body in an ambient field). Typically, weathering elevates the magnetic susceptibility, so soils have a higher MS than their parent rock. Anthropogenic processes (particularly heating) may also enhance MS. Thus, the fills of archaeological cut features typically show a higher magnetic susceptibility than the substrate into which they are cut (and thus appear as positive anomalies). There are exceptions to this sense of susceptibility contrast – for instance, where a cut feature is filled by stone with low magnetic susceptibility. For structures built of stone, there is typically a stronger contrast between the lower MS stonework and higher MS occupation deposits (meaning that stone walls, drains, etc., will usually show negative magnetic anomalies).

Ferrous materials will usually strongly influence the magnetic gradient but to a limited spatial extent. These anomalies typically show strong negative and positive components (so a small iron object appears as a black/white dot on the plots). Accumulations of iron objects may generate a speckled appearance – typical, for instance, of the sites of former wire fences. The remanent magnetic fields of CBM may also produce speckled textures – brick rubble will appear similar to a spread of ferrous debris but with lower magnitude 'spikes'.

5 GEOPHYSICAL INTERPRETATION

5.1 General

The site comprises a large western field in Kellystown townland. To the east in Porterstown Townland are three land parcels, and the area encompassed by St Mochrans Football Club. The boundary between the two townlands is sinuous.

During the survey, the fields in the far southern corner of the site stored farm machinery. Surveying around this has had the combined effect of fragmenting the area as well as introducing significant background noise into the dataset. The road in the south and the hardstanding areas to the north and east of the sports fields are underlain by material with a very high ferrous content. No archaeological assessment can be made of these areas.

The central field is depicted as being bisected by a ditch on early OS mapping. The topographic survey shows this follows a line of low elevation with the eastern part of the survey. This line is continued to the west by the low ground along the NW margin of the western field and, outside the survey area to the west, by a stream flowing SSW into the Woodlands Demesne.

Within the area encompassed by the football club is a single broad linear positive magnetic anomaly. Oriented almost N-S, this feature correlates with a field boundary on early OS maps. The southern of the three main sportsfields is underlain by a spread of ferrous material, which broadly coincides with a square field present on early OS maps originally associated with Porterstown village and then, later, with Porterstown house.

The field to the south of the sportsfields shows noisy magnetic properties, probably mostly associated with its use as a construction compound. A single broad linear positive magnetic anomaly passes WNW-ESE through the area. This direction parallels various post-medieval field boundaries in the close area, although it does not correspond to any boundary recorded on old OS mapping.

The field immediately to the west of the football club shows no discrete magnetic anomalies indicative of buried features. Still, it does show a high level of ferrous point anomalies and an area of 'speckled' anomaly at its southern end – perhaps because of its proximity to the partially demolished farmyard of Porterstown House, just to the south.

The central field shows (apart from the central anomaly mentioned above, which is probably the culvert from the canalised watercourse) several composite linear anomalies of finely-spaced high amplitude ferrous type anomalies. These probably represent the remains of former metallic fencing, although they might be strongly magnetic ceramic drains. These features are visible in recent aerial photography (e.g. Google Earth images).

In the southern part of the central field are two positive magnetic anomalies: the eastern (centred upon [705932, 737501]) measures 11mx7m, and the western (centred upon [705864, 737507]) measures 8mx6m. Two similar anomalies occur in the western field: the eastern (centred upon [705687, 737471]) is 10mx10m, and the western (centred upon [705645, 737410]) is 8mx6m. These four anomalies have the characteristics of large pits, and the most common purpose for structures of this size is as field ponds. Typically, these were constructed at one per field for stock watering. In this instance, no geophysical evidence exists for separating these features by early field boundaries.

The western field shows two sets of agricultural lineations (NNE-SSW, i.e. parallel to the E boundary, and NNW-SSE). This field has very little ferrous debris compared with the eastern ones. The field shows some high amplitude anomalies along its margins, associated with recent field boundaries (e.g. to the SW) and probably the debris of former boundaries (e.g. to the N).

This field shows three areas of more potential significance, numbered 1 to 3 from W to E and described in more detail below.

5.2 Sites of Archaeological Potential

5.2.1 Site 1

This area extends from the western corner of the field for approximately 120m eastwards. In the west of the area, some broad (4m), moderately high-amplitude, positive linear magnetic anomalies run parallel to the northern margin of the field for approximately 85m. These anomalies may be early courses of the stream that runs along the boundary.

Over the first 55m from the field corner, a series of at least 5 (and maybe 7) positive magnetic anomalies of similar character but slightly narrow run SSE perpendicularly away from this boundary. These are suggestive of some form of agricultural activity in elongated plots rather than regular 'ridge-and-furrow' type ploughing, perhaps harnessing water from, or draining water into, the bounding channel.

At around 55m from the corner, the boundary channel(s) swings slightly more to the north.

At 90m from the corner, where the boundary channel lies just outside the survey area, is the western side of a sub-rectangular enclosure that extends 42m SSE from the channel. The western side starts from the north approximately perpendicular to the channel but swings slightly S. Its course is prolonged to the S by a lower amplitude anomaly that is approximately parallel to the NNW-SSE anomalies in the west corner of the field. The western side of the enclosure turns NE for 13m before returning to the channel (in a somewhat sigmoidal way) at a point approximately 25m NE of the N end of the western side. Strands of more closely N-S anomalies

complicate this E side of the enclosure, perhaps suggesting reworking of the E of the enclosure. These anomalies suggest a ditched enclosure bounded to the N by the channel and on the other sides by a ditch 1.5m to 3m in width. Internally, the enclosure shows a narrow positive linear anomaly with a 10m long S side and a 13 m long E side forming a sub-enclosure, centred upon [705528, 737472] against the western side.

The SE corner of the enclosure shows an almost N-S positive linear anomaly forming an external tangent. Similarly oriented linear segments occur parallel to this and to the east. These anomalies appear to curve slightly as they pass towards the present southern edge of the field. They appear to be agricultural lineations (furrows?) rather than discrete archaeological features. Indeed, they align closley with the much lower amplitude NNE/SSW agricultural lineation visible over much of the eastern half of the field.

These observations may suggest that the enclosure lies in a triangular gap between two early fields.

The final elements of this site (although excluded largely from the site boundary) are very low amplitude positive magnetic anomalies that appear to delimit an enclosure extending to the SE of the main enclosure just described. These anomalies are barely above background noise, and the significance of this apparent enclosure (or field) is uncertain.

5.2.2 Site 2

This area includes two lengths of divergent irregular, narrow positive magnetic anomalies. They leave the southern site boundary at [705684, 737423], passing to [705679, 737469] and [705713, 737472]. The eastern branch may swing NW to [705697, 737478] and possibly context with the end of the western branch around the NW of the area anomaly interpreted above a field pond, although this section is at background levels. These anomalies may constitute an irregular enclosure of approximately 58m x 32m. The location of the 'pond' with the NW corner of this potential enclosure may be significant or a coincidence.

A broad sinuous positive magnetic anomaly extends southeastwards for about 75m from the southern tip of this potential enclosure. It terminates after a short section of parallel ditches in what appears, possibly, to be a gateway at [705742, 737373].

5.2.3 Site 3

This site covers a possible ring ditch (centred upon [705651, 737419]), marked by a very low amplitude positive annular magnetic anomaly. The anomaly is barely above background variation, and identifying this as a potential ring ditch must be considered very tentative. If it is a circular anomaly, it is 9m in diameter with a ditch 1m to 1.5m wide, possibly open to the SSE.

5.3 Summary

This area has provided evidence for four possible field ponds (one possibly associated with an irregular enclosure), a tentative ring ditch, and a sub-rectangular substantial ditched enclosure, possibly set between two adjacent agricultural regimes.

Disclaimer

This report represents an opinionated interpretation of the geophysical data. It is intended for guidance with follow-up invasive investigation. Features that do not produce measurable geophysical anomalies or are hidden by other features may remain undetected. Geophysical surveys complement invasive/destructive methods and provide a tool for investigating the subsurface; they do not produce data that can be taken to represent all of the ground conditions found within the surveyed area. Areas that have not been surveyed due to obstructed access or any other reason are excluded from the interpretation.

Figures

705400 705500 705600 705700 705800 705900 706000 706100 706200 706300

737800 737700 737600 737500 737400 737300

N

Magnetic Gradient
nT
-3.9 -3.4 -2.8 -2.2 -1.7 -1.1 -0.5 0.1 0.6 1.1 1.6 2.1 2.6 3.1 3.6

Title:
RAW MAGNETIC GRADIOMETRY - +/- 4 nT

Project:
KELLYSTOWN

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FIGURE 1

705400 705500 705600 705700 705800 705900 706000 706100 706200 706300

737800 737700 737600 737500 737400 737300

N

Magnetic Gradient
nT
-3.9 -3.4 -2.8 -2.2 -1.7 -1.1 -0.5 0.1 0.6 1.1 1.6 2.1 2.6 3.1 3.6

Title:
PROCESSED MAGNETIC GRADIOMETRY - +/- 4 nT

Project:
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Drawn by/Ref: CB/8858/2
Date: 23/02/2023

FIGURE 2

N

- Strong positive feature
- Weak positive feature
- Weak negative feature
- 'Speckled' magnetic anomaly
- Extent of survey
- Extent of site
- Ferrous feature
- Strong agricultural lineation
- Potential archaeology

Title:
SUMMARY ARCHAEOLOGICAL INTERPRETATION

Project:
KELLYSTOWN

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Date:	23/02/2023

FIGURE 3

705400 705500 705600 705700 705800 705900 706000 706100 706200 706300

737800 737700 737600 737500 737400 737300

1 2 3

N

Strong positive feature
Weak positive feature
Weak negative feature
'Speckled' magnetic anomaly
Extent of survey
Extent of site
Ferrous feature
Strong agricultural lineation
Potential archaeology

Topography
Low — High

Title: **SUMMARY ARCHAEOLOGICAL INTERPRETATION WITH TOPOGRAPHY**

Project: **KELLYSTOWN**

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FIGURE 4